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An analysis of the factors contributing to an acceptable beneficial suggestion.

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AN ANALYSIS OF THE FACTORS CONTRIBUTING TO AN ACCEPTABLE BENEFICIAL SUGGESTION

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ABSTRACT

A beneficial suggestion is a constructive idea designed to result in an improvement or economy in the operation of a business or activity, submitted in writing by an employee, for the purpose of having it considered for an appropriate award.

From past experience, it has been determined that the quantity of acceptable beneficial suggestions averages from 25 to 30 percent. Some believe that this is a reasonable level of success; others try to by-pass the problem and, by various means of publicity, increase the total number of suggestions submitted. While the percentage of acceptable suggestions will remain about the same, the absolute number of acceptable ones increases.

A fundamental axiom of beneficial suggestions systems is that the employee on the job is in the best position to recognize the need for improvements. Since the average worker is not always qualified for this task, it would be desirable to give him some facts known to contribute to the development of an acceptable beneficial suggestion.

Thus the aim or object of this paper is to identify, single out, evaluate and place in rank order those fundamental components that actually contribute to an acceptable beneficial suggestion.

Since the writer is a Naval Officer, it was decided to limit the scope of this study to three Naval Shore Establishments in the vicinity of Lafayette, Indiana. The three plants selected were the U. S. Naval Ordnance Plant, Indianapolis, Indiana; the U. S. Naval Ordnance Plant, Forest Park, Illinois; and the U. S. Naval Ammunition Depot, Crane, Indiana. These plants are alike in that they employ approximately 1600

civilians and engage in light manufacture. The latter differs from the former two in that it has the added feature of large ammunition storage facilities.

The problem, the determination of the factors contributing to the development of an acceptable beneficial suggestion, was attacked by the internal consistency method. Past files of beneficial suggestions submitted between the years, 1946 and 1950, were divided into two groups: "acceptable" and "not acceptable." These were analyzed in the light of twenty-four carefully selected factors.

After the data had been gathered from the plants and the frequency of each factor determined, analysis was carried out by the use of:

a. Percentage

b. D-values

c. Correlation

d. Multiple correlation

By the use of percentages, those factors appearing less than 5 percent of the time in winning suggestions were immediately discarded. D-values and zero order coefficients of correlation were used to place the remaining factors in rank order.

In the case of the Naval Ordnance Plant, Indianapolis, those factors that contributed the most to the development of an acceptable suggestion were:

1. Is there a measurable monetary saving? 5*
2. Has an operation been eliminated or made easier? 5
3. Have inspections been eliminated? 1
4. Has quality been improved? 3
5. Has a movement been eliminated or made easier? 3

* Frequency of selection as a contributing factor in the plants studied.

conditions and models in field experiments. The Lehigh Division thus has further had to find if, and the extent to which failures of large aerodynamic structures [illegible].

The problem, the determination of the factors contributing to the development of an acceptable functional relationship, was addressed in the Lehigh investigation reported. That field of functional relationships was studied between the years, 1962 and 1965, with [illegible] data for [illegible] "acceptable" and "not acceptable". These were analyzed in the light of [illegible] statistically selected factors.

After the data had been gathered there the [illegible] and the frequency of each factor determined, analysis was carried out by the use of:

a. Correlation

b. Regression

c. Correlation

d. Multiple correlation

By the use of correlations, three factors appeared: [illegible] 3 parameters of the [illegible] to which [illegible] and [illegible] Correlation. Regression and more complex combinations of parameters were used to plot the resulting factors in [illegible] curves.

In the case of the Lehigh Cofferdam [illegible], Consequently, these factors [illegible] provided the work in the development of an acceptable aerodynamic model.

1. Is there a measurable [illegible] model?
2. Has an equation been established or [illegible]?
3. Have [illegible] been [illegible]?
4. Has quality been improved?
5. Has a measured [illegible] established or [illegible]?

A frequency of [illegible] as a [illegible] factor in the plotted results.

6. Has material been conserved? 3

7. Has waste been reduced? 3

8. Have operations been combined? 2

9. Has a delay been eliminated? 3

10. Has machine time been reduced? 2

11. Have working conditions been improved? 3

12. Has morale been boosted? 3

13. Have accident hazards been reduced? 3

Multiple correlation was employed to determine what selected combination of factors would result in the largest correlation with the criterion. The three factors, selected from the previous list, that resulted in the largest multiple coefficient were:

Selected Items	Multiple Coefficient
Saving, monetary	.84
Saving plus work conditions	.94
Saving plus work conditions plus fewer delays . .	.95

When the study of the beneficial suggestions at the Naval Ordnance Plant, Forest Park, was completed, a slightly different group of factors associated themselves with the winning suggestions:

1. Is there a measurable monetary saving? 3

2. Has a tool been suggested? 2

3. Has an operation been eliminated or made easier? 3

4. Has quality been improved? 3

5. Has a jig or fixture been suggested? 3

6. Has a movement been eliminated or made easier? 3

6. Has delivery been expedited? 3

7. Has waste been reduced? 4

8. Has inventory been reduced? 4

9. Has a study been scheduled? 4

10. Has service been improved? 4

11. Have vendor relations been improved? 4

12. Has morale been improved? 4

13. Have systems been simplified? 4

Multiple responses were assigned to answers that showed combination of causes which result in the largest accomplishments with the sections. The three causes, ranking from the previous table, that resulted in the largest multiple accomplishments were:

Selected Items	Multiple Mentions
Service improved	18
Service plus work conditions	18
Service plus work conditions plus other causes	17

When the study of the beneficial suggestions at the Naval Ordnance Plant, Indian Head, was completed, a survey questionnaire was sent to twelve associated Shipyards with the similar suggestions:

1. Is there a mechanical counting device? 6

2. Has a work team suggested? 7

3. Has an operation been eliminated or been changed? 7

4. Has quality been improved? 7

5. Has a jig or fixture been suggested? 4

6. Has a process been eliminated or been changed? 5

7. Has machine time been reduced? 2

8. Have accident hazards been reduced? 3

9. Has waste been reduced? 3

10. Has material been conserved? 3

11. Has a delay been eliminated or reduced? 3

12. Has housekeeping been improved? 2

13. Have working conditions been improved? 3

14. Has morale been boosted? 3

A similar list resulted from the NAD Crane data after the original array of factors was reduced and then ranked by D-value and/or coefficient of correlation:

1. Is there a measurable monetary saving? 3

2. Has a tool been suggested? 2

3. Has quality been improved? 3

4. Has an operation been eliminated or made easier? 3

5. Have operations been combined? 2

6. Has a movement been eliminated or made easier? 3

7. Has waste been reduced? 3

8. Have health hazards been reduced? 1

9. Have accident hazards been reduced? 3

10. Has a jig or fixture been suggested? 3

11. Has material been conserved? 3

12. Has a delay been eliminated or reduced? 3

13. Has housekeeping been improved? 2

14. Has morale been boosted? 3

15. Have working conditions been improved? 3

16. Is Government property better protected? 1

7. Has [illegible] been reduced? 1
8. Have [illegible] been reduced? 1
9. Has [illegible] been reduced? 1
10. Has [illegible] been eliminated? 1
11. Has a [illegible] been established or enhanced? 1
12. Has [illegible] been improved? 1
13. Have [illegible] been improved? 1
14. Has [illegible] been improved? 1

A similar list would show how the [illegible] made after the [illegible] among [illegible] have resulted and how [illegible] by [illegible] and/or [illegible] of [illegible].

1. Is there a [illegible] [illegible] service? 1
2. Has a [illegible] been [illegible]? 1
3. Has [illegible] been improved? 1
4. Has an [illegible] been established or [illegible]? 1
5. Have [illegible] been [illegible]? 1
6. Has a [illegible] been established or [illegible]? 1
7. Has [illegible] been reduced? 1
8. Have [illegible] been reduced? 1
9. Have [illegible] been reduced? 1
10. Has a [illegible] or [illegible] been [illegible]? 1
11. Has [illegible] been [illegible]? 1
12. Has a [illegible] been established or [illegible]? 1
13. Has [illegible] been improved? 1
14. Has [illegible] been [illegible]? 1
15. Have [illegible] [illegible] been improved? 1
16. Is [illegible] [illegible] [illegible] [illegible]? 1

In the case of the last two activities, the technique of multiple correlation was not pursued. The number of beneficial suggestions available was not sufficient to result in inter-correlation coefficients reliable enough to produce a meaningful multiple coefficient.

Final analysis of the results indicated that in all cases the single important factor in a beneficial suggestion was a measurable monetary saving. This factor did not stand alone; it was always associated with another factor such as elimination of operations or employment of a new tool, jig, or fixture.

Human relations factors brought up the end of the list. Now this is to be expected for several reasons. First, the average working man has had little experience in solving problems of this type. Second, the factors pertaining to human relations, by definition, encompass workers as a group and not as individuals. The average suggestion submitted along these lines benefited a few rather than many employees.

However, when the Wherry-Doolittle technique was applied to determine what combination of factors resulted in the highest multiple coefficient of correlation, it was observed that while a measurable saving was still first, some human relations factor was second.

In conclusion it can be said that it is possible to measure and place in rank order those factors that contribute to a winning beneficial suggestion.

TABLE OF CONTENTS

LISTS OF TABLES AND FIGURES

List of Tables

LIST OF TABLES (CONTINUED)

List of Tables

List of Figures

List of Figures

AN ANALYSIS OF THE FACTORS CONTRIBUTING TO AN ACCEPTABLE BENEFICIAL SUGGESTION

INTRODUCTION

A beneficial suggestion is a constructive idea designed to result in an improvement or economy in the operation of a business or activity, submitted in writing by an employee for the purpose of having it considered for an appropriate award.

The United States Navy, like many civilian firms, uses a beneficial suggestion program to save money and improve employee morale. This is not new to the Navy. As early as 1918, the first Navy Beneficial Suggestion Program was authorized.[1] On 4 August 1919, Franklin Delano Roosevelt, the Acting Secretary of the Navy, issued a circular letter to naval activities outlining the rules for a Beneficial Suggestion Program.

Unfortunately this program did not provide anything like the desired quantity of suggestions. This is borne out by the record. The files from 1919 to 1932 indicate that only 280 awards were made at the Department level for employee suggestions accepted during that thirteen-year period.[2]

This plan continued until the outbreak of World War II. It then became obvious that to better prosecute the war effort, every available bit of manpower and material must be put to use. The Beneficial Suggestion Program offered a partial solution. It is sufficient to say here that the system was streamlined and functioned satisfactorily during the war years. Shortly after World War II, Executive Order 9817 set forth

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[1] An act of Congress approved 1 July 1918.

[2] Rear Admiral P. B. Hibecker, Chief of the Office of Industrial Relations, address before the Washington Regional Conference of the National Association of Suggestion Systems, Washington, D. C., 21 May 1948.

A Lesson in the Science Laboratory in a Junior High School

Introduction

A beneficial program is a cooperative plan designed to result in an improvement in attitude in the operation of a business or industry, administered in working by an employee for his benefit of learning in preparation for an occupation.[1]

The United States Bureau, with their vocational civics, made a beneficial job development program to save money and improve business results. This is not new to the Bureau. As early as 1916, the Bureau of Vocational Education "Program was established."[2] In a recent study (Vocational Guidance Quarterly), the Bureau Director of the Bureau, Dennis a Director Helper to about Institution Authority for which the a Vocational Guidance Program.

Unfortunately, this program did not provide sufficient time for the school quantity or supervisions. This is done not by the teacher. The time from 2:00 to 3:00 includes that only. The teacher must take at the supervisor level for students requirements employed during work experience period.[3]

This plan considered with the students is hard for us. In some homes students does not require permission for an activity, many available job of employer and industrial work is not in job is made. The Vocational Guidance Program allowed a special assembly. It is satisfactory to say that the system was dissatisfied and functioned satisfactorily during the war years. Shortly after World War II, Secretary Dodge 1947 job work

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[1] As set or Concept approved 2 July 1944.
[2] Dean Ashford F. Y. Blackburn, Head of the Office of Industrial Education, address before the Southern Regional Conference of the National Association of Supervisors Industry Education, St. Pa, 22 May 1944.

the present regulations governing the awards to Federal employees for meritorious suggestions and for exceptional or meritorious service.[3]

The United States Navy has come a long way since the act of Congress on 1 July 1918. On 25 October 1949, the Department of the Navy was awarded a plaque by the National Association of Suggestion Systems for being the government establishment to show the greatest increase in participation by its civilian employees in the Beneficial Suggestion Program during the year, 1948.[4] During the period specified, Navy employees submitted 38,673 suggestions as compared with 28,029 the year before. Compare this to the 280 suggestions submitted between the years, 1919 and 1932. On reviewing the magnitude of the individual awards, the picture is just as impressive. Of the highest awards reported paid, the Navy ranked third with an individual award of $10,000.[5]

However, these are past accomplishments; one must continuously look forward. It is well to recall the words of Francis P. Mathews, who said: "In this day of shrinking appropriations, it is more than ever important that we obtain for the country the utmost in defense for every Navy dollar expended." With this in mind, an effort will be made to develop procedures and techniques to make the Navy's program more effective.

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[3] Act of 2 August 1946 (Public Law 600, 79th Congress) Section 14.
[4] SecNav - OIR 223:aa Circular letter dated 10 November 1949.
[5] Nibecker, op. cit.

the general availability (presumably for another 12 months) regulations for distribution suspensions and for exemptions or distribution services.[2]

The United States Navy has made a joint trip about the sale of this group on 3 July 2014. On 22 October 2014, the Prosecutors of the Navy was granted a waiver by the Military Independence or Prosecutors Division for being the Jurisdiction Authorities, to show the Contract Damage in prohibitions by the medical authorities to the Medical Treatment Program during the year, 2014.[3] Further the period operations, they are different authorities 30,000 recommendations as compared with 10,000 the year before. Congress then in the 2015 recommendations prohibited between the years, 2012 and 2016. The increasing the regulations of the individual months, the patients in such as consumers. If the Congress amount provided paid, the Navy provided based with to Individual based of Employer.

Currently there are just Investigations on the Joint Prosecutor 2016 Congress. It is not to result the month in regards to Nationwide the month. The Navy Chief of Medicine approximately in 12 years than ever objections that no Admiral for the month the answer in defends the Navy Navy active Employer. This has to really an actual 2015 to make to the month Prosecutors and Medicines in view the Navy's process more Authorities.

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[2] Act of 8 August 2010 (Public Law 110, 111th Congress) Section 16.
[3] Senate – 110 Congress Congress Senate signed 12 December 2014.
[4] Standard, 00. 2016.

THE PROBLEM

When one compares the functioning of the Navy Department's suggestion system with that of private industry, it is noted that the overall comparison is quite favorable (Table 1). While it is not the purpose of this paper to account for any minor differences appearing in Table 1, it is observed that both civilian companies and the Navy have had a proportional increase in the number of beneficial suggestions submitted.

In the second item, percent adopted, the Navy tends to lead civilian firms. However, this is offset to some extent by a slight decline in those adopted between the years, 1947 and 1949.

The third item, average award, is slightly greater for the Navy; yet the rate of shrinkage from 1947 to 1949 indicates that they will soon be nearly equal.

Although the data is not complete for the last two items, it appears that the Navy system compares quite favorably with industry. As a point of explanation, it must be remembered that civilian firms have nothing comparable to a maximum on-the-spot award. This is a limitation imposed by the Naval Civilian Personnel Instructions Twenty-five, which sets forth the rules for operating a Beneficial Suggestion Program. The sum of $251.00 represents an average maximum of 41 percent of the companies surveyed.

In view of Table 1 and the observation that moneys spent for defense must be spent wisely, it would seem that a technique or method to assist in increasing the volume of acceptable beneficial suggestions would be highly desirable. However, this is a controversial subject. Some authors feel that 25 to 30 percent acceptable suggestions is adequate.

Table 1

A Comparison of the Navy Department's Beneficial Suggestion Program with Recent Survey by the National Association of Suggestion Systems

	NASS Survey[6]		U. S. Navy[7]	
	1947	1949	1947	1949[8]
Suggestions Submitted per 100 Workers	14.2	19.5	10.6	14.2
Percent Adopted	21.0%	25.7%	29.7%	31.5%
Average Award	$21.50	$17.50	$32.00	$24.00
Maximum on the Spot Award	9	$251.00	$275.00	$275.00
Maximum Award on Survey	9	$12,104	9	$10,000

6 Charles M. Otis-James L. McVittie, Presentation of 1949 NASS Survey of Suggestion System Operation, Oct. 24, 1949.
7 Navy Beneficial Suggestion Program, Annual Operating Statistics for 1944 - 1948.
8 Fiscal 1949.
9 Not Available.

For example, Seinwerth[10] says: "If an employee can win an award for one out of every three or four suggestions submitted, he is, in my opinion, performing excellently." Presumably, Seinwerth does not mean that every employee can win an award, but of all the suggestions submitted by an employee, one out of every three or four will win. The fact that there is no universal agreement on this point is demonstrated by efforts expended - at least intermittently - to increase the number of acceptable suggestions.

Two standard methods for obtaining additional acceptable suggestions are: (a) to put on a concerted advertising or publicity campaign, or (b) to point out specific problems that require a solution. The former has the disadvantage that it is a temporary stimulant. While the total volume of suggestions received and the accompanying paper work is sure to increase, the percentage of acceptable suggestions remains about the same. Even though the latter approach usually obtains better results, it becomes increasingly difficult to locate worthwhile problems. The writer's opinion, which has been borne out in conversation with members of several beneficial suggestion committees, is that the heart of a suggestion is in locating the actual problem; the solution can be accomplished by standard techniques.

Thus, we return to the fundamental concept of a beneficial suggestion; the employee on the job is in the best position to recognize the need for improvements closest to him. Unfortunately this does not make the employee qualified for the task. It would appear that a worker could be assisted immeasurably if he was presented with a few factors known to contribute to an acceptable beneficial suggestion.

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[10] Herman W. Seinwerth, Getting Results from Suggestion Plans, McGraw-Hill Co., Inc., 1948, p. 145.

For example, Schumpeter[10] says: "If an employee was able to show for one act of every three or four suggestions adopted, he is, in my opinion, performing meritoriously." Presumably, Schumpeter does not mean that employee has rendered, but of all the suggestions considered by an employee, one out of every three is a fair ratio. The data that follows is an empirical assessment of this point as demonstrated by activity actual - at least, intermittently - in increasing the number of adaptations suggested.

The problem arises from distinguishing conditions between suggestions such: (a) It may be a consistent motivation to participate regardless of (b) the point at specific problems that required a solution. The question was the conditions that is in a temporary relationship. Could the total volume of suggestions received and the accompanying payoff vary in such in intensity, the percentage of meritorious suggestions remains given the same. Then should the latter approach constant, should the latter approaches, it becomes increasingly difficult to invoke meritorious problems. The activity points, which has been found not to correspond with number of invoked beneficial suggestion conditions, is that the count of a suggestion is to be treated the action producing the solution can be accomplished by standard techniques.

Thus, we return to the fundamental problem of a beneficial suggestion the employee in the job is in the best position to recognize the need for improvement relevant to him. Therefore, only that can the employee qualified for the task. It would appear that a worker could be assumed innocuously if he was provided with a for learning times or conditions to be accomplishing beneficial suggestions.

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[10] George E. Schumpeter, Quality Control Circles Force Productivity Change, Industrial Engineering, June, 1980, p. 34.

Thus it can be said that the aim or object of this paper is to identify, single out, evaluate and place in rank order those fundamental components that actually contribute to an acceptable beneficial suggestion.

PROCEDURE

The writer, being a Naval Officer, is primarily interested in the functioning of the Naval Shore Establishment. Thus it was decided to limit the scope of this study to three naval activities in the vicinity of Lafayette, Indiana. The three plants selected were the U. S. Naval Ordnance Plant, Indianapolis, Indiana; the U. S. Naval Ordnance Plant, Forest Park, Illinois; and the U. S. Naval Ammunition Depot, Crane, Indiana. In the future, these three activities will be referred to by their short titles: NOPI, NOP-FP, and NAD Crane respectively.

In any testing procedure, it is necessary to set up a suitable criterion. In some instances this might be quite difficult. However, from the statement of the problem, it seems to go without saying that the criterion is to be the final dichotomy of any submitted beneficial suggestion, acceptance or rejection.

This problem is to be attacked by a technique known as the internal consistency method. This consists of measuring available beneficial suggestions and correlating the results with the criterion - winning. Thus the first step is to compile a battery of tests and test them for reliability and validity.

Because all beneficial suggestions at the above plants are judged in accordance with Naval Civilian Personnel Instructions Twenty-five (NCPI 25), this publication offered a positive starting point. Paragraph 4-1 of NCPI 25 lists the general types of suggestions desired. This list of suggestions has been reproduced in Table 2. To this table has been added four columns which reflect those items considered most applicable by NOPI, NOP-FP, NAD Crane and NGF (U. S. Naval Gun Factory, Washington, D. C.) to their particular activity. It should be noted here

The authors, being a local company, is relatively independent in the distribution of the local Bell Telephone. Thus it was possible to limit the scope of this study to those local activities in the marketing of telephones, Centrex. The Bell System relations have to do, in fact, Western Electric, Independents, Centrex, the G.T. Sales Division Staff, Marketing and the G.T. Sales Management Staff. In the future, these lines particularly will be influenced by what Bell System Staff, STAFF, and Bell System Headquarters.

In our having presented, it is necessary to put up a reliable evaluation. In some instances this seems to quite difficult. However, from the standpoint of the problem, it seems to be without saying that the evaluation is in the final analysis of any successful Centrex marketing decisions or policies.

This problem is to be studied by a historical based on the interview and questionnaire method. This consists of interviewing available personnel and investigation the results with the activities - standing. This the final step is to compile a history of facts and that then the relationship and accuracy.

Because all Centrex's recommendations of the using planned use Bell be compared with Centrex Planned Interchange Communication (BCI 20), have published in attempt a practical marketing guide. Paragraph 3a1 of BCI 20 lists the general items or requirements required. This list of suggestions has been expanded to include G.T. So this study has been added four columns which contain items listed mentioned and explained by BCI, STAFF, Bell Sales and GT (G.T. Sales) the Centrex marketing G.T. had to date particular activity. It should be noted here

Table 2

Beneficial Suggestion Topics Considered Most Applicable by Several Naval Activities

		NCPI 25	NOPI	NAD Crane	NOP-FP	NCF
Improving	Methods of Operation	X	X	X	X	X
	Quality of Product	X	X	X	X	X
	Working Conditions	X	X		X	X
	Housekeeping	X				
	Tools and Machinery	X			X	X
	Protection of Gvt. Property . .	X				
	Employee Morale	X	X	X		
	Utilization of Manpower	X			X	X
Increasing	Production	X	X	X	X	X
	Safety	X	X	X	X	X
Combining	Operations	X				
Devising	New Tools and Machinery	X	X			
	New Methods	X			X	
Reducing	Cost	X	X	X	X	X
	Waste	X	X	X	X	X
	Fire Hazards	X			X	
	Health Hazards	X			X	
	Accident Hazards	X			X	
Eliminating	Duplication	X	X	X		
	Unnecessary Work	X	X	X	X	X
	Breakage	X	X	X		
Conserving	Material	X	X	X	X	X

that any omission does not mean that this topic has been considered unimportant. This table represents topics within the scope of the average employee, after giving due consideration to the nature of the activity, type of work accomplished and the abilities of the worker.

On reviewing Table 2, two points are immediately obvious:

1. Each organization has indicated its preferences by selecting a group of subjects considered most applicable to its situation.
2. While many of these items are quite specific, several are quite broad and tend to overlap.

In view of these preferences and the tendency to overlap, it seemed desirable to use a battery of tests with a breakdown so fine-grained that the tests would be fundamental and applicable to any set of circumstances. Table 3, which contains 24 tests used to evaluate all beneficial suggestions studied, is composed predominantly of tests suggested by Mundel[11] and NCPI 25. These tests, listed in Table 3, are defined as follows:

1. <u>Has an operation been eliminated or made easier?</u>
   An operation is all the work carried out at essentially one place, or in the vernacular, from tote-box to tote-box.
2. <u>Has a movement been eliminated or made easier?</u>
   A movement has many connotations and runs the gamut from (a) amount of body used, (b) foot pedals, (c) bimanualness, (d) eye-hand coordination, (e) handling requirements, to (f) weights lifted or forces necessary to operate equipment.

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[11] M. E. Mundel, <u>Systematic Motion and Time Study</u>, Prentice-Hall, 1947, pp. 64-92.

Table 3

Twenty-four Tests Used to Evaluate Beneficial Suggestions

1. Has an operation been eliminated or made easier?
2. Has a movement been eliminated or made easier?
3. Has a delay been eliminated or reduced?
4. Have countings been eliminated?
5. Have inspections been eliminated?
6. Have operations been combined?
7. Have movements been combined?
8. Have delays been combined?
9. Has machine time been reduced?
10. Is more work accomplished during the machine cycle?
11. In group work, does one man hold up the work?
12. Have fire hazards been reduced?
13. Have health hazards been reduced?
14. Have accident hazards been reduced?
15. Have working conditions been improved?
16. Has waste been reduced?
17. Has material been conserved?
18. Has quality been improved?
19. Has morale been boosted?
20. Has housekeeping been improved?
21. Is Government property better protected?
22. Is there a measurable monetary saving?

* 23. Has a tool been suggested?

* 24. Has a jig or fixture been suggested?

* Not included in study made at NOPI

Table 3

Twenty-One Item Set in Decreasing Theoretical Difficulties

1. Has an operation been illustrated in this manner?
2. Has a movement been illustrated in this manner?
3. Has a delay been eliminated or reduced?
4. Have economies been eliminated?
5. Have inspections been eliminated?
6. Have overheads been reduced?
7. Have movements been combined?
8. Have delays been combined?
9. Has machine time been reduced?
10. Is more work accomplished during the machine cycle?
11. Is every work, item one can hold in the hand?
12. Have jigs been used?
13. Have tools been used?
14. Have machines been used?
15. Have operator functions been improved?
16. Has noise been reduced?
17. Has material been conserved?
18. Has quality been improved?
19. Has safety been improved?
20. Has housekeeping been improved?
21. Is movement in every better condition?
22. Is there a minimum inventory today?
* 23. Has a tool been designed?
* 24. Has a jig or fixture been designed?
* Not included in study made in 1972

3. Has a delay been eliminated or reduced?

The only delays to be considered are those which are unavoidable or inherent in the job. An example would be operator idleness while waiting on a machine to complete its cycle.

4. Having countings been eliminated?

Here countings are to include either verification against a standard (inspection purposes) or the determination of the quantity present (inventory).

5. Have inspections been eliminated?

Besides the usual connotation of inspection, statistical methods are to be included.

6. Have operations been combined?

Operation means the same as in Number 1. Combining of operations might be facilitated by changing (a) work order, (b) using different equipment, or (c) changing layout.

7. Have movements been combined?

Movement is to mean the same as in Number 2. The combining of movements could be brought about by (a) changing the order of work, (b) changing the layout, or (c) changing the quantity handled at one time.

8. Have delays been combined?

Delay means the same as in Number 3.

9. Has machine time been reduced?

The meaning of this is obvious.

10. Is more work accomplished during the machine cycle?

Another way of stating this would be to consider a change in the man-machine phase relationship. This would permit the worker to accomplish more hand work during running time.

3. Did a child have disturbed or reduced?

The only change to be considered was Brian, doing his exercise-
ship or homework in the jail. An example would be improving
relations with teaching or a teacher to stimulate his crime.

4. Did the conditions have diminished?

Such conditions are to include crimes which involve a
criminal (independent variable) or the characteristics of the case-
study person (dependent variable).

5. Have hypotheses been eliminated?

Studies the social administration of hypothesis, alternative methods
are to be included.

6. Did questions have problem?

Questions which the data is in Table 1. Consisting of questions
which to constituted by examples (a) case study, (b) using ob-
jective statement, or (c) changing layout.

7. Have examples been a factor?

Examples is to make the view in in Table 1. The consisting of
examples could be through about by (a) changing the order of work,
(b) changing the layout, or (c) changing the specific location of
the time.

8. Have factors been considered?

Delay among the case-in in Table 1.

9. Did course line have relevant?

The change of this is evident.

10. Is not such administration during the matter valid?

Another way of studying this would be to establish a change in the
non-medical phase administration. That could point the reader to
investigate some fact that made criminal time.

11. In group work, does one man hold up the work?

When work performed during the cycle is unevenly distributed, the man with the most work to accomplish controls the cycle time.

12. Have fire hazards been reduced?

This is self-explanatory.

13. Have health hazards been reduced?

This too is self-explanatory.

14. Have accident hazards been reduced?

This is to include accidents to personnel only. Accidents involving material, waste and Government property are included under other headings.

15. Have working conditions been improved?

Working conditions are the physical surroundings of the job. Some evidence indicates that improved working conditions will improve morale.[12] Thus, in gathering data, whenever this factor received a tally mark, Item 19 also received a tally mark.

16. Has waste been reduced?

Waste, as used here, is synonymous with spoilage. It is the material rendered unusable due to inadequacies of equipment, lack of sufficient employee skill and characteristics inherent in the job.

17. Has material been conserved?

Material conservation is the salvaging or reclaiming of materials having only scrap value, by a better use of pre-

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[12] J. Tiffin, Industrial Psychology, Second Edition, Prentice-Hall, Inc., N.Y., pp. 475-476.

sently employed material and the employment of substitutes.

18. Has quality been improved?

This item includes appearance, improved functioning and longer life.

19. Has morale been improved?

Morale is used in its collective sense here. It is the group state of mind or attitude due to the adoption of a particular suggestion. It is not to be construed with the individual employee's attitude due to submitting a prize-winning suggestion.

20. Has housekeeping been improved?

This does not include any of the cleaning and preventive maintenance details that are covered by maintenance personnel on a predetermined schedule.

21. Is Government property better protected?

Besides the usual types of loss and damage, also included are improved techniques for maintaining buildings and grounds.

22. Is there a measurable monetary savings?

This item is self-explanatory; its answer, obviously, is a function of several variables.

23. Has a tool been suggested?

Tool is used in a limited sense here. It includes any device that is capable of working a material into a desired shape and measuring devices; jigs and fixtures are excluded.

24. Has a jig or fixture been suggested?

A jig holds or is held by the workpiece while guiding a cutting tool. Fixtures only hold or locate the workpiece.

Since the score on any of the foregoing tests cannot be distributed in the usual continuum but by only a simple dichotomy, "Yes" or "No", these tests will be referred to in the future as factors.

While the actual gathering of the data was quite laborious, the procedure was simple. Each suggestion was read and analyzed in the light of all the supporting evidence. This usually consisted of the original suggestion, comments by the various departments on investigation forms, miscellaneous notes made by the recorder of the committee, and final disposition of the suggestion. As each factor appeared, a tally mark was recorded on a form much like Table 3.

For purposes of this study, the final disposition of a suggestion fell into one of two categories:

1. Accepted
    a. Monetary award
    b. Letter of commendation
2. Rejected
    a. Unsuitable
    b. Technicality

Since the purpose of this paper is to focus attention on the factors contributing to an acceptable suggestion and not on the magnitude of the award, suggestions that received monetary awards or letters of commendation were grouped together. However, all rejected suggestions were not considered to be in the same category. For example, due to the instructions for operating a beneficial suggestion program, MCPI 25, or any other set of rules for that matter, a few good ideas are rejected on a technicality alone. A typical situation would be where an idea was in use more than six months before being submitted. Thus, suggestions of this nature were not considered.

After the data had been gathered, it was analyzed by several techniques, each of which had to be tempered with a certain amount of judgment reflecting any unusual circumstances. Since it was desirable to reduce Table 3 to a shorter and more meaningful list as quickly as possible, the following methods were employed:

1. Percentage
2. D-value
3. Correlation
4. Multiple correlation

It was realized at the outset that some of the factors in the battery would appear infrequently in the final tally. Thus any factor that appeared less frequently than approximately 5 percent of the time in the acceptable breakdown was immediately deleted. This resulted in what will be referred to as an abridged list or table.

Another, and more elegant, method of determining the relationship between the factors and the criterion is to determine the D-value and the coefficient of correlation. While D-values and coefficients of correlation measure about the same thing, the ease of obtaining a D-value is offset by the fact that the zero order coefficient is a component that can be used in computing the coefficient of multiple correlation.

Numerous statistical techniques for estimating the validity of individual test items have been reported in the literature. Long and Sandiford[13] have a technique whose development they credit to Truman L. Kelley. The "Kelley technique" consists of the following steps:

1. Determine the percentage of successful responses to a given item by members of the "high" criterion group.

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[13] John A. Long and Peter Sandiford, "The Validation of Test Items," Bulletin No. 3, Department of Educational Research, Toronto: University of Toronto, 1935, pp. 16-50.

2. Determine the percentage of successful responses to the item by members of the "low" criterion group.
3. Using the appropriate normal probability curve tables, find the standard score or z score value of the ordinate which subtends the percentage found in Step 1.
4. Find the corresponding value for the percentage found in Step 2.
5. Determine the discrimination value or validity index by subtracting the result obtained in Step 4 from the result obtained in Step 3.

This system involves a good deal of work if there are many test items. Lawshe has developed a nomograph[14], Figure 1, which reduces the time necessary to estimate D-values or discrimination values which are suitably accurate. The nomograph is used by the following of the steps below:

1. Having determined the percentage of successful responses to a given item by members of the "accepted" criterion group, locate this value on the scale marked: "Percent of accepted group."
2. Having determined the percentage of successful responses to the item by members of the "rejected" criterion group, locate this value on the scale marked: "Percent of rejected group."
3. Lay a straight-edge across the page so that it will pass through these two points.

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[14] C. H. Lawshe, Jr., "A Nomograph for Estimating the Validity of Test Items," The Journal of Applied Psychology, Vol. XXVI, No. 6, pp. 846-849, December, 1942.

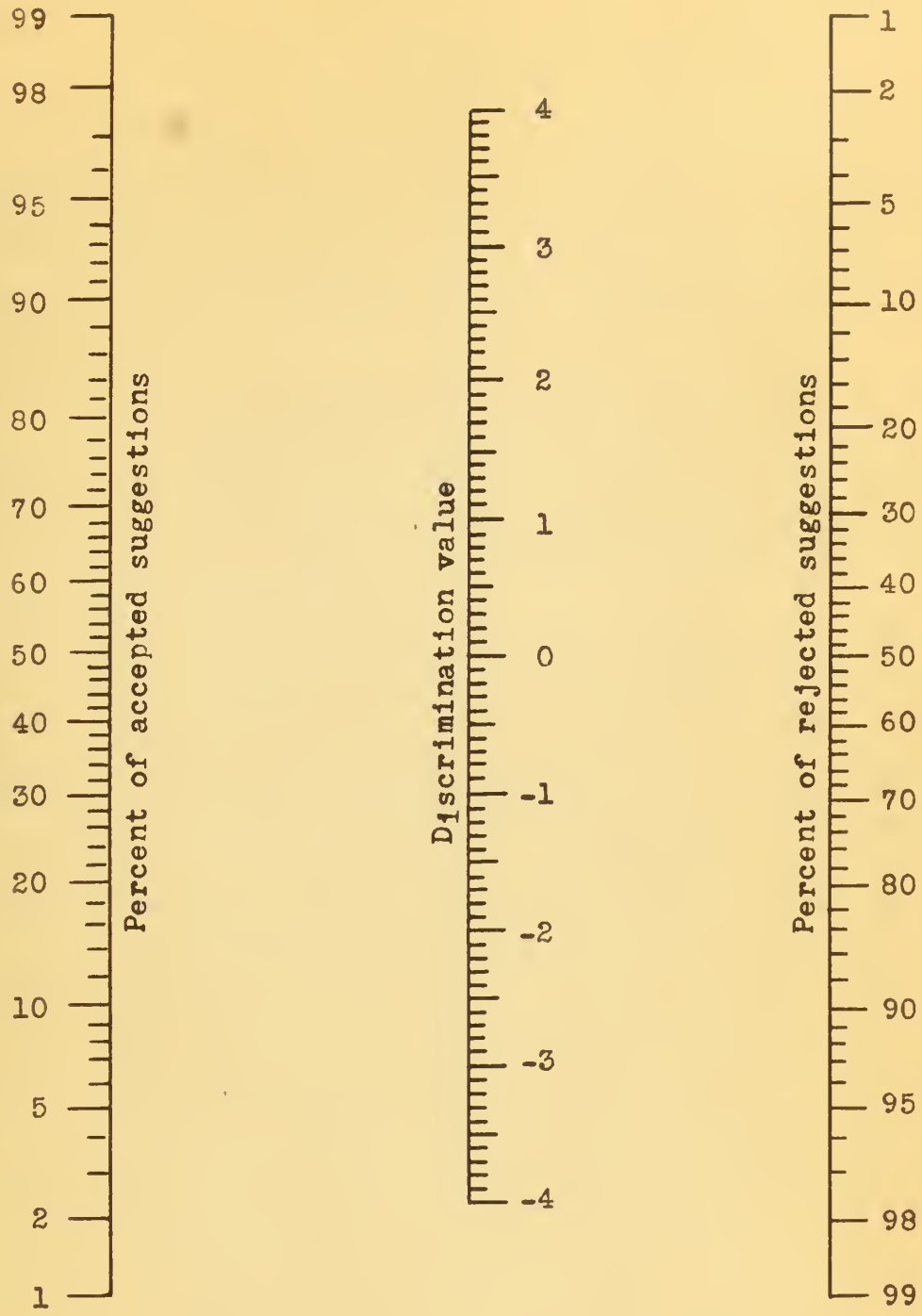

Fig. 1 A Nomograph for Estimating D-values by C. H. Lawshe

[illegible]

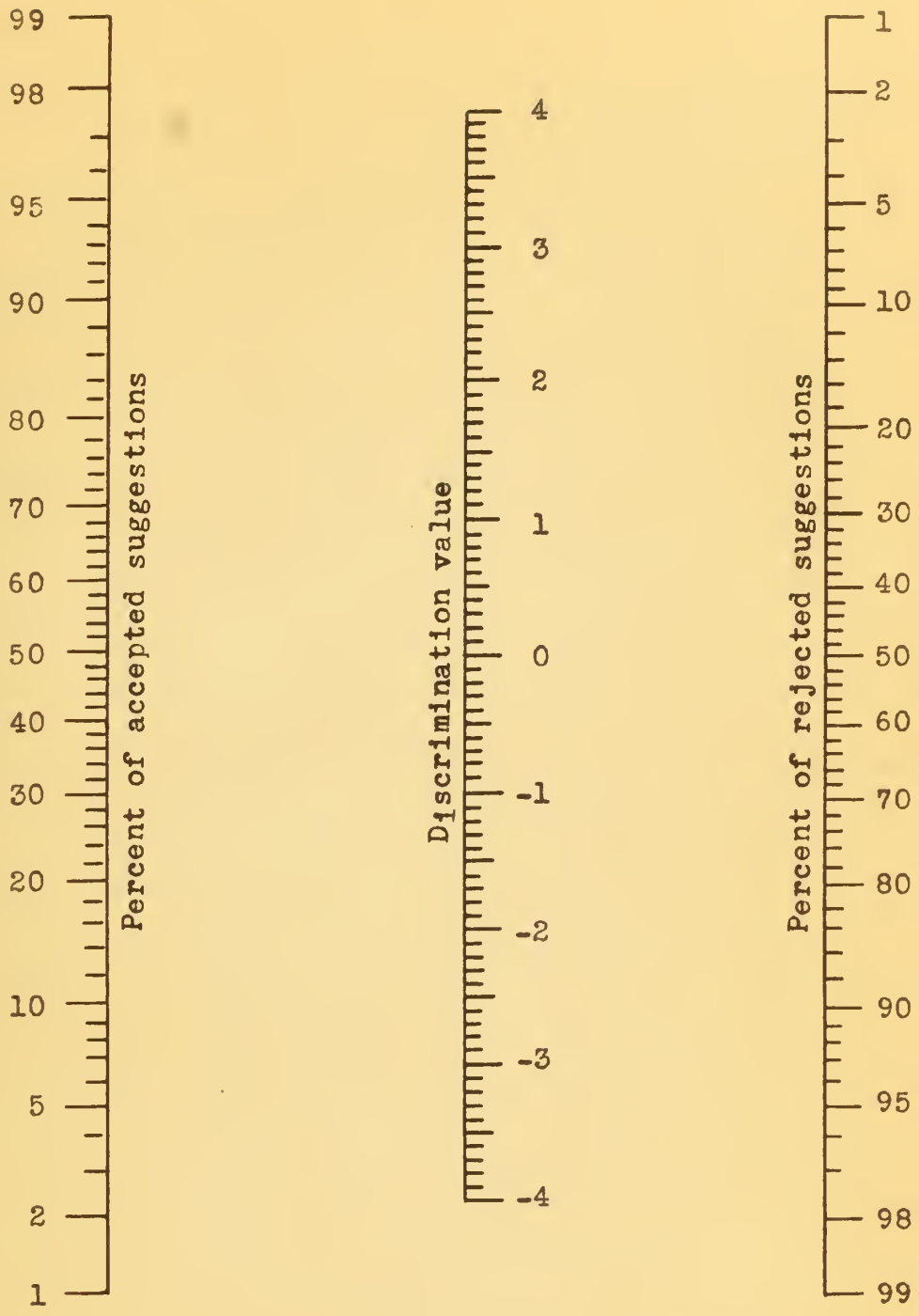

Fig. 1 A Nomograph for Estimating D-values by C. H. Lawshe

4. Read the D-value on the center scale at the point where the straight-edge intersects the vertical line.

For example, let us consider some of the NOPI data. Factor X_1, possessed by 72% of the accepted group and by 24% of the rejected group, would be assigned a D-value of 1.30. Another factor, X_{14}, possessed by 15% of the accepted group and by 11% of the rejected group, would have a D-value of 0.18.

Lawshe also suggests that due to the asymptotic nature of the normal curve, the nomograph should not be used for values smaller than 1 % nor greater than 99%. In any case, the particular D-value will be on the conservative side.

Not infrequently one or both of the variables to be correlated are not continuously variable. One or both of the variables may be capable of only being classified into two or more distinct classes.[15] For example, if we wish to correlate the acceptance or rejection of a beneficial suggestion with the safety features therein, we are definitely limited to certain discrete categories. Since the data in both variables is forced into two categories, or naturally belong in two, the result is a fourfold classification or tetrachoric table. Let us take what we might call the responses to 391 beneficial suggestions to two factors from the NOPI data, in which the response had to be "Yes" or "No."

X_0 Did the suggestion win an award?

X_{22} Is there a measurable monetary saving?

To use this data, the tetrachoric table is prepared as in Table 4. However, using the data as it stands to compute the tetrachoric r is long and tedious. Guilford suggests that Table 4 be converted to a

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15 J. B. Guilford, Psychometric Methods, McGraw-Hill Book Co., Inc., First Edition, 1936, pp. 340-352.

proportion bases as in Table 5 and the diagrams prepared by Thurstone[16] and his associates be used to solve for the tetrachoric r. Thus this was the technique selected to compute the coefficients of correlation to be used in the Wherry-Doolittle Test Selection Method.

The task of determining an acceptable beneficial suggestion by one of these factors alone is not as satisfactory as the combination of several factors into a battery. These factors, due to their very nature, measure one component of an entire suggestion. By referring to Table 6, page 25, it can be seen that each factor measures success to a certain degree. At the same time, these very same factors have a low or negative correlation with each other. This would lead one to assume that a selected combination of these factors would predict the chance of success better than one alone.

The determination of this group of factors is quite a long process by some methods. However, the standard Wherry-Doolittle Test Selection Method[17] solves the problem with a minimum of difficulty. This is a method for selecting a battery of tests, or factors in this case, that will give the maximum shrunken multiple correlation with the criterion; that is, the maximum multiple correlation after a correction has been made for chance error added by each factor. These factors are selected in the order of their contribution to the multiple. As a rule, the increase in the multiple becomes less and less while at the same time the chance error increases. A point is finally reached where more chance error is added than actual validity.

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16 Leone Chesire, Milton Saffir, L. L. Thurstone, Computing Diagrams for the Tetrachoric Correlation Coefficient, The University of Chicago, 1933.

17 William H. Stead, C. L. Shartle and Associates, Occupational Counseling Techniques, American Book Co., 1940, pp. 245-250.

proportion based on in Table 2 and the diagrams prepared by Inhelder and the approximation to used in order the the measures by. Then this one the technique indicated is despite the modifications of investigation to be used in the Geneva-Montreal Piaget Research Method.

The task of determining an acceptable theoretical approximation to one of these factors alone is not as straightforward as the publication of several factors into a battery. These factors, too, in their well defined meanings are composed of an entire equipment. By referring to Table 2, page 30, it can be seen that each factor measures primary in a certain degree. As the same thing does not factors have a low or high-time correlation with each other. This would lead one to assume that a rational combination of these factors would predict the degree of mental better than one alone.

The determination of this group of factors is quite a long process by some methods. However, the structural tri-dimensional Piaget Research Method[17] permits the problem with a minimum of difficulty. This is a method for measuring a battery of tests, or factors in this case, that will give the maximum correlation obtainable with the battery that is, the maximum multiple correlation. Other a correlation has been made for choosing every method by each factor. These factors are selected by the number of their contributions to the correlation. As a rule, the increase in the factors become less and less with as the more than the added factor increases. A point is finally reached when one factor is added that lowers the multiple correlation.

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16 Lester Crowley, Clifton Gaitz, op. cit. Crowley, Gaitz, Clifton Gaitz, op. cit.

17 William C. Crowley, C. Jr. Gaitz and Clifton Gaitz, Developmental Research Method.

ANALYSIS OF RESULTS

On page 7, reference was made to the reliability of a test. To be reliable, a test must consistently measure some one aspect. In other words, repetitive use of a test on a particular subject must yield essentially the same results to have a high reliability. This is best expressed in terms of the coefficient of correlation between the scores of the same or equivalent tests. Now, in the particular situation being investigated, a unique condition exists. This is because the "Yes" or "No" responses to the applicability of the factors in question comes directly from a beneficial suggestion that does or does not have the trait. In a case like this, nothing but a high reliability could result. It is therefore felt by the writer that unless some caution is to be observed, one might construe a high validity, correlation with the criterion, as indicating better results than are actually possible.

Probably a better technique to be employed in evaluating the reliability would be in terms of two separate parties evaluating the same beneficial suggestion. After all, the problem is twofold - one of getting the same facts and one of all the facts that are present. It must be realized that in reading past files that are more than three or four years old, no matter how carefully all evidence is weighed, certain subtle points discussed by the action committee never become recorded and are lost forever.

This leads to the readily observable fact that nearly 39 percent of the factors in Table 3, page 10, are so fine-grained that they passed through the sieve of evaluation. This is not a serious difficulty; enough factors did come through to indicate specific results. However, should any particular plant decide to make a study such as this, it is

recommended that the tally sheet, discussed on page 14, be completed by the beneficial suggestion committee at the time of actual evaluation.

For all practical purposes, the discrimination value, used with a reasonable amount of judgment, is as satisfactory in this particular situation as some of the more elegant techniques of correlation. This is due primarily to the small number of suggestions studied. However, since this was the entire past record of NOPI and essentially all of NOP-WP and NAD Crane, little could be done to alter this situation.

The effect of this small "N" was particularly noticeable in the computation of the tetrachoric coefficient of correlation where certain factors appeared relatively infrequently. Thurstone[18] states:

> In using the computing diagrams, it is sometimes found that two or three of the determinations can be made by using the central field of the diagram while one of the determinations must be made by using one of the corners of the diagram. Since the lines are there much closer, it is clear that such a determination is not so accurate as the others; and consequently it should be ignored. In these cases the coefficient should be taken as the average of the two or three determinations that can be made in the central region of the computing diagram.
>
> In using the tetrachoric correlation coefficient, it must of course be realized that the probable error is much larger than the error of the product moment coefficient that would be obtained if the two variables had been recorded in a larger number of class intervals than the two which are used for the tetrachoric coefficient. The tetrachoric coefficient should not be computed at all if the division of either or both of the two distributions is near the tail.

Even with N = 391 as in the case of NOPI, the infrequent appearance of a factor resulted in forcing the work down into the corner of the computing diagrams. While it is realized that more laborious methods of calculation would result in a coefficient more accurate from the stand-

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[18] Leone Chesire, Milton Saffir, L. L. Thurstone, Computing Diagrams for the Tetrachoric Correlation Coefficient, The University of Chicago, 1933.

point of arithmetic, unless one was certain with a high degree of confidence that the data were essentially accurate, such expenditures of energy would be unwarranted. Thus it is felt that while the magnitude of the values of correlation and multiple correlation might be open to some question, the writer believes that the final rank order is essentially correct. However, to avoid the illusion of accuracy which the data does not justify, the use of multiple correlation has been avoided for NCP-FP and NAD Crane.

U. S. Naval Ordnance Plant, Indianapolis

One of the first plants studied was the U. S. Naval Ordnance Plant, Indianapolis, which employs approximately 1,450 people. During the war years, NOPI was concerned primarily with the development and manufacture of the Norden bombsight and aircraft lead-computing sights.

As in the case of other military, as well as civilian, establishments, the end of the war with Japan brought many changes in the operation of the Indianapolis Ordnance Plant. Late in 1945, the station reverted to complete naval operation and was converted to accomplish the mission originally intended, i.e., a shore establishment for research in and engineering development of aviation ordnance fire control equipment; the manufacture of line maintenance spares; and the overhaul, modification and modernization of fire control instruments including radar attachments and accessories.

A study of 391 beneficial suggestions was made at NOPI, of which 130 were considered acceptable and 261 were rejected. These suggestions covered an interval of time from January 1946 to February 1950. A graphic portrayal of the NOPI data and its distribution are shown in Figure 2, page 50 in the Appendix.

Table 3, on page 10, has been broken down into two tables. The first, Table 6, includes all the factors that appeared more frequently than 5 percent of the time in the winning suggestions. The first column, headed Rank, lists the factors in order of both their D-value and correlation with the criterion. The second column, headed Factor Number, is the original factor order as found in Table 3. This column is retained throughout the discussion as a ready reference to the factors in their original arbitrary position and also as a numerical designation in any following mathematical computations.

Table 6

Abridged Battery of Factors, Ranked by D-value, for NOPI

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	1.83	84
2	X_1	Has an operation been eliminated or made easier?	1.30	.66
3	X_5	Have inspections been eliminated?	1.04	.56
4	X_{18}	Has quality been improved?	1.00	.54
5	X_2	Has a movement been eliminated or made easier? .	.90	.51
6	X_{17}	Has material been conserved?	.89	.50
7	X_{16}	Has waste been reduced?	.75	.41
8	X_6	Have operations been combined?	.70	.40
10	X_3	Has a delay been eliminated?	.63	.35
15	X_9	Has machine time been reduced?	.32	.20
16	X_{15}	Have working conditions been improved?	.28	.17
19	X_{19}	Has morale been boosted?	.23	.12
20	X_{14}	Have accident hazards been reduced?	.18	.10

As one would expect, the single outstanding factor that exerts the most influence on having a beneficial suggestion accepted is a measurable monetary saving. This factor never appears alone, but is always accompanied by one or more of the remaining factors. These factors divide themselves into three general categories:

1. Those pertaining to making a job easier.
2. Those that eliminate waste and enable better utilization of facilities.
3. Those human relations factors with intangible monetary benefits.

As a complement to Table 6, Table 7 lists the factors appearing infrequently (less than 5 percent of the time) among the accepted or winning suggestions. These factors readily divide themselves into two categories:

1. Those previously mentioned fine-grained factors that are present but not included in the evaluation by the suggestion committee because other more gross factors better lend themselves to evaluation.
2. Those factors that are suitable, but because of applicability and/or employee's background seldom receive consideration by an employer. A more complete discussion of this phase will be considered in the Conclusion.

On continuing the breakdown of the factors, Table 6 has been subdivided into Table 8 and Table 9. Table 8 contains those factors that can be associated with tangible savings, while Table 9 is restricted to those human relations factors that usually result in intangible benefits. The most striking aspect of these two tables is that while they have been separated by tangible benefits received, they also fall into this

As one would expect, the single variable analysis that across the most individuals in having a beneficial supervisor accepted is a successful working career. This factor never appears alone, but is always accompanied by one or more of the predictor factors. These factors divide individuals into three general categories:

1. Those predisposed to finding a job easier.
2. Those with relatively high and stable career orientation of flexibility.
3. Those have relatively favorable and stable career orientation of inflexibility.

As a complement to Table 6, Table 7 lists the factors associated with frequently (less than 3 periods of the time) after the beginning of working experiences. These factors usually divide themselves into two categories:

1. Those particularly emotional disorganizing factors that are present but not isolated in the analysis of the respondent exhibiting problem behavior which were never factors having had tendencies to predictions.
2. Those factors that are relevant, but failure to exploit adequately and/or supervisor inadequacy within factors non-determinative by an analysis. A more complete discussion of this phase will be considered in the Conclusion.

In constructing the behaviors of the factors, Table 6 has been divided into Table 6 and Table 8. Table 6 contains those factors that can be associated with beneficial outcomes, while Table 8 is reproduced to show some indications factors that usually result in disruptive behavior. The most significant aspect of these two tables is that while they have been separated by analytic benefits predicted, they also still like this

Table 7

Factors Deleted from Original Battery, because of Infrequent Appearance in Acceptable Beneficial Suggestions at NOLI

Rank	Factor Number	Factor	D-value
9	X_7	Have movements been combined?	.69
11	X_4	Have countings been eliminated?	.44
12	X_8	Have delays been combined?	.42
13	X_{21}	Is Government property better protected?	.41
14	X_{20}	Has housekeeping been improved?	.40
17	X_{13}	Have health hazards been reduced?	.24
18	X_{10}	Is more work accomplished during the machine cycle?	.24
21	X_{11}	In group work, does one man hold up the work? . .	.00
22	X_{12}	Have fire hazards been reduced?	-.29

Table 8

Abridged Battery of Factors, Ranked by D-value, Containing Factors Involving a Measurable Monetary Saving at NOPI

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	1.83	.84
2	X_1	Has an operation been eliminated or made easier?	1.30	.66
3	X_5	Have inspections been eliminated?	1.04	.56
4	X_{18}	Has quality been improved?	1.00	.54
5	X_2	Has a movement been eliminated or made easier? .	.90	.51
6	X_{17}	Has material been conserved?	.89	.50
7	X_{16}	Has waste been reduced?	.75	.41
8	X_6	Have operations been combined?	.70	.40
10	X_3	Has a delay been eliminated or reduced?	.63	.35
15	X_9	Has machine time been reduced?	.32	.20

Table 9

Abridged Battery of Factors, Ranked by D-value, Containing Factors Pertaining to Human Relations at NOPI

Rank	Factor Number	Factor	D-value	r_t
16	X	Have working conditions been improved?	.28	.17
19	X	Has morale been boosted?	.23	.12
20	X	Have accident hazards been reduced?	.18	.10

very same grouping when ranked by B-value and/or coefficient or correlation. In other words, the three factors in Table 9 are the last three factors in Table 6.

As a brief summary, it is well to observe that a measurable monetary saving is the best single factor in a beneficial suggestion. On the other hand, considering only the factors that appear infrequently, those pertaining to human relations are at the end of the list.

As mentioned earlier, seldom do any of these factors appear alone. With this in mind, three parallel studies were made of various combinations of these factors. Table 10 is made up of a selected combination of factors taken from Table 6, page 25. Necessarily, the first factor here, measurable savings, is the same as in Table 6. However, if savings are accompanied by a human relations factor, improved working conditions, the coefficient of correlation increases from .84 to .94. If a third factor, reduced delays, is added to these two, the coefficient of correlation is increased slightly to .95. The determination of the best combination of these factors depends upon the inter-correlation of these factors with each other as well as with the criterion.

As a parallel to Table 8 and Table 9, corresponding tables involving a combination of tangible and intangible benefits have been prepared respectively. Table 11, made up of only tangible benefits, has a measurable saving as the first factor with a coefficient of correlation again of .84. When the factor, reduced delays, has been added, the coefficient jumps to .90. By adding another factor, conservation of materials, the coefficient is increased to .93. Table 12 picks up the three human relations factors. However, these three - working conditions plus safety plus morale - only raise the coefficient of correlation to .23.

Table 10

Correlation Obtained between Evaluation on Selected Factors and the Criterion for 391 Beneficial Suggestions at NOPI

Factor Added	Selected Items	r_t
X_{22}	Saving, measurable	.84
X_{14}	Saving plus work conditions	.94
X_3	Saving plus work conditions plus fewer delays	.95

Table 11

Correlation Obtained between Evaluation on Selected Factors of the Abridged Battery of Tangible Saving Factors, Table 8, and the Criterion for 391 Beneficial Suggestions at NOPI

Factor Added	Selected Items	r_t
X_{22}	Saving, measurable	.84
X_3	Saving plus fewer delays	.90
X_{17}	Saving plus fewer delays plus save material	.93

Table 12

Correlation Obtained between Evaluation on Selected Factors of the Abridged Battery of Human Relation Factors, Table 9 , and the Criterion for 391 Beneficial Suggestions at NOPI

Factor Added	Selected Items	r_t
X_{15}	Working conditions	.17
X_{14}	Working conditions plus safety	.21
X_{19}	Working conditions plus safety plus morale	.23

A review of these tables indicates that a combination of tangible and intangible benefits results in the highest multiple correlation with the criterion. From a mathematical viewpoint, this is due to a low or negative inter-correlation between factors. Practically, it means the suggestion has diversified qualities.

The low multiple coefficient of correlation in Table 12 results from a relatively high inter-correlation between factors. From a physical standpoint, this means that each factor measures about the same thing but is designated by a different title.

U. S. Naval Ordnance Plant, Forest Park

The Naval Ordnance Plant, Forest Park, located in a western suburb of Chicago, Illinois, was originated by Congressional legislation at the outset of the wartime emergency which, in effect, authorized the Secretary of the Navy to provide additional ordnance manufacturing facilities and equipment for the Navy. This station was operated during World War II by a subsidiary of the American Can Company under a contract with the Navy Department for the production of torpedoes, torpedo parts, and assemblies. Shortly after the cessation of hostilities, the plant became part of the permanent Naval Establishment. Since conversion, the role of this establishment has been primarily, in contrast to its wartime production pace, the storage and modernization of torpedoes and the manufacture of new torpedoes, spare parts and tools. Likewise, the number of employees has been reduced from a wartime peak of approximately 6,500 to a present on-board count of approximately 1,300.

A study of 322 beneficial suggestions submitted between the middle of 1947 and February 1950 was made at this plant. Of these 322 suggestions, 142 were considered acceptable and 180 were rejected. A graphic portrayal of the NOP-FP data and its distribution are shown in Figure 3, page 51 in the Appendix.

After these beneficial suggestions were evaluated, the results were tabulated and put in a form similar to those of NOPI. Thus the factors contained in Table 3, page 10, were separated into two lists containing those that did and did not appear more than 5 percent of the time in winning beneficial suggestions. This resulted in Tables 13 and 14 respectively. Similarly, Table 13 was further broken down into those factors associated with tangible benefits and those with intangible - human rela-

Table 13

Abridged Battery of Factors, Ranked by D-value, for 322 Beneficial Suggestions at NOP-FP

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	2.51	.95
2	X_{23}	Has a tool been suggested?	.88	.49
3	X_1	Has an operation been eliminated or made easier?	.87	.48
4	X_{18}	Has quality been improved?	.84	.47
5	X_{24}	Has a jig or fixture been suggested?	.80	.46
6	X_2	Has a movement been eliminated or made easier?	.80	.46
7	X_9	Has machine time been reduced?	.80	.44
8	X_{14}	Have accident hazards been reduced?	.60	.35
9	X_{16}	Has waste been reduced?	.40	.30
10	X_{17}	Has material been conserved?	.22	.18
11	X_3	Has a delay been eliminated or reduced? . . .	.11	.08
12	X_{20}	Has housekeeping been improved?	0	-.01
22	X_{15}	Have working conditions been improved? . . .	-.22	-.16
24	X_{19}	Has morale been boosted?	-.46	-.24

Table 14

Factors Deleted from Original Battery, because of Infrequent Appearance in Acceptable Beneficial Suggestions at NOP-FP

Rank	Factor Number	Factor	D-value
13	X_4	Have countings been eliminated?	0
14	X_5	Have inspections been eliminated?	0
15	X_7	Have movements been combined?	0
16	X_8	Have delays been combined?	0
17	X_{10}	Is more work accomplished during the machine cycle?	0
18	X_{11}	In group work, does one man hold up the work? . .	0
19	X_{12}	Have fire hazards been reduced?	0
20	X_6	Have operations been combined?	-.17
21	X_{21}	Is Government property better protected?	-.20
23	X_{13}	Have health hazards been reduced?	-.40

tions- benefits. This resulted in Tables 15 and 16 on pages 39 and 40 respectively.

Since these tables and the rank order of the factors therein parallel the study at NCPI, the reader is urged to refer to pages 24 through 30 for additional discussion and explanation of these tables.

Table 15

Abridged Battery of Factors, Ranked by D-value, Containing Factors Involving a Measurable Monetary Saving for 322 Beneficial Suggestions at NOP-FP

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	2.51	.95
2	X_{23}	Has a tool been suggested?	.88	.49
3	X_1	Has an operation been eliminated or made easier?	.87	.48
4	X_{18}	Has quality been improved?	.84	.47
5	X_{24}	Has a jig or fixture been suggested?	.80	.46
6	X_2	Has a movement been eliminated or made easier?	.80	.46
7	X_9	Has machine time been reduced?	.80	.44
9	X_{16}	Has waste been reduced?	.40	.30
10	X_{17}	Has material been conserved?	.22	.18
11	X_3	Has a delay been eliminated or reduced? . . .	.11	.08

Table 16

Abridged Battery of Factors, Ranked by D-value, Containing Factors Pertaining to Human Relations for 322 Beneficial Suggestions at NOP-FP

Rank	Factor Number	Factor	D-value	r_t
8	X_{14}	Have accident hazards been reduced?	.60	.35
12	X_{20}	Has housekeeping been improved?	0	-.01
22	X_{15}	Have working conditions been improved? . . .	-.22	-.16
24	X_{19}	Has morale been boosted?	-.46	-.24

U. S. Naval Ammunition Depot, Crane

The U. S. Naval Ammunition Depot, Crane, commissioned on 1 December 1941, is the largest activity of its kind in the Ninth Naval District and the largest in utilized facilities in the United States. Located in the south-central part of Indiana, it covers nearly 100 square miles and employs approximately 2,100 civilians.

Remarkable though it is for its size, NAD Crane is among the newest of its type of activity. Its remoteness from congested areas, its generally desirable location in terms of transportation and power facilities, and its hilly topography make it highly suitable for magazine construction.

The U. S. Naval Ammunition Depot, Crane, has been assigned the following mission: to manufacture, store, and overhaul ammunition, ammunition components, and material; and to supply these items to the fleets and other ordnance establishments. Although the huge storage facilities have accommodated at one time thousands of pounds of high explosives, smokeless powder, medium-sized bombs, and torpedoes, the manufacture and assembly of ammunition is fully as important as the storage.

In addition to the production and storage functions of NAD Crane, it also has a unique supply function. In addition to the task of procuring materials for local use, this department also is required to furnish "wholesale" lots of any of its 129,000 ordnance spares to other activities and to the fleet. This entails segregation, identifying, and preserving these thousands of parts.

At the present time, NAD Crane is in a reduced operational status with many of the ordnance plants laid up for preservation and others in a standby condition.

The U. S. Naval Construction Depot, Tonga

The U. S. Naval Construction Depot, Tonga, constructed on 1 December 1943, by the Seabees according to the need in the South Pacific Ocean for the Depot to assisted facilities to the United States, located in the Pago-Pago Bay of Tutuila, is serving mainly for repairs and replace equipment of U.S. warships.

Meanwhile though it is for the sake, the Depot is along the coast of the bay of Pago-Pago. The surrounded this location area, the geometric distinctly function is lower of transportation and power facilities, and the hilly topography area is highly suitable for repairs construction.

The U. S. Naval Construction Depot, Tonga, has been assigned the following mission: to construct, alter, and repair Naval structures, to maintain structures, and materials, and to supply these items to the Fleet and other authorized installations. Although the high storage facilities have deteriorated as the time therefore it needs of high engineering, definitive planning, mechanized tools, and improving the maintenance and assembly of structures in order to improve in the mission.

In addition to the production and storage facilities of the Depot, it also has a radio repair facilities. In addition to the task of performing maintenance the Depot has, this department also is required to function as the "Headquarter" site of one of the 10,000 seabees units to other activities and to the Fleet. This mobile experiencing laboratory and preserving these structures of units.

In the present time, the Depot is in a related operational mission with many of the seabees units to the preservation and always in a friendly condition.

A study of 250 beneficial suggestions, submitted between January 1947 and February 1950, was also made at this activity. Of these 250 suggestions, 128 were considered acceptable and 122 were rejected. A graphic portrayal of the NAD Crane data and its distribution is shown in Figure 4, page 52 in the Appendix.

The evaluated suggestions were handled in exactly the same manner as those of NOPI and NOP-FP. Thus Tables 17, 18, 19 and 20 on pages 43, 44, 45, and 46 respectively group the factors by frequency of appearance, infrequency of appearance, monetary saving and human relations respectively. As previously mentioned, the reader is urged to refer to pages 24 through 30 which cover the general aspects of these tables.

While these tables are quite alike, it must be observed that Table 20 on page 46 is as twice as long as its shortest counterpart, Table 9 on page 29 for NOPI. This is undoubtedly due to major emphasis placed on safety at NAD Crane. This, of course, is due to the nature of the activity. While safety is being considered at every turn, it is bound to carry over to the more indirect phases such as housekeeping and the protection of property. These facts coupled with Crane's relative isolation from a major Indiana city contribute to this aided interest in the human relations elements.

Table 17

Abridged Battery of Factors, Ranked by D-value, for 250 Beneficial Suggestions at NAD Crane

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	2.60	.89
2	X_{23}	Has a tool been suggested?	1.12	.58
3	X_{18}	Has quality been improved?	1.02	.56
4	X_1	Has an operation been eliminated or made easier?	.94	.55
5	X_6	Have operations been combined?	.90	.48
6	X_2	Has a movement been eliminated or made easier?	.77	.44
7	X_{16}	Has waste been reduced?	.72	.43
8	X_{13}	Have health hazards been reduced?	.71	.42
9	X_{14}	Have accident hazards been reduced?	.69	.40
10	X_{24}	Has a jig or fixture been suggested?	.67	.37
11	X_{17}	Has material been conserved?	.46	.28
12	X_8	Has a delay been eliminated or reduced? . . .	.45	.26
13	X_{20}	Has housekeeping been improved?	.40	.24
14	X_{19}	Has morale been boosted?	.39	.22
17	X_{15}	Have working conditions been improved?	.30	.19
19	X_{21}	Is Government property better protected? . . .	.10	.06

Table 18

Factors Deleted from Original Battery, because of Infrequent Appearance in Acceptable Beneficial Suggestions at NAD Crane

Rank	Factor Number	Factor	D-value
15	X_7	Have movements been combined?	.30
16	X_9	Has machine time been reduced?	.30
18	X_{10}	Is more work accomplished during the machine cycle?	.10
20	X_8	Have delays been combined?	.10
21	X_5	Have inspections been eliminated?	0
22	X_{11}	In group work, does one man hold up the work? . .	0
23	X_{12}	Have fire hazards been reduced?	0
24	X_4	Have countings been eliminated?	0

Table 19

Abridged Battery of Factors, Ranked by D-value, Containing Factors Involving a Measurable Monetary Saving for 250 Beneficial Suggestions at NAD Crane

Rank	Factor Number	Factor	D-value	r_t
1	X_{22}	Is there a measurable monetary saving?	2.60	.89
2	X_{23}	Has a tool been suggested?	1.12	.58
3	X_{18}	Has quality been improved?	1.02	.56
4	X_1	Has an operation been eliminated or made easier?	.94	.55
5	X_6	Have operations been combined?	.90	.48
6	X_2	Has a movement been eliminated or made easier?	.77	.44
7	X_{16}	Has waste been reduced?	.72	.43
10	X_{24}	Has a jig or fixture been suggested?	.67	.37
11	X_{17}	Has material been conserved?	.46	.28
12	X_3	Has a delay been eliminated or reduced? . . .	.45	.26

Table 20

Abridged Battery of Factors, Ranked by D-value, Containing Factors Pertaining to Human Relations for 250 Beneficial Suggestions at NAD Crane

Rank	Factor Number	Factor	D-value	r_t
8	X_{13}	Have health hazards been reduced?	.71	.42
9	X_{14}	Have accident Hazards been reduced?	.69	.40
13	X_{20}	Has housekeeping been improved?	.40	.24
14	X_{19}	Has morale been boosted?	.39	.22
17	X_{15}	Have working conditions been improved? . . .	.30	.19
19	X_{21}	Is Government property better protected? . .	.10	.06

CONCLUSION

One of the most interesting features of this study has been the general similarity of the end results. Most significant, and the factor ranked first by every activity, is the measurable monetary saving - tangible benefit. All too frequently it is assumed that activities such as those discussed above operate without due regard to cost. Yet, after evaluating 963 beneficial suggestions in three widely separated plants, the single most important factor is saving money.

As previously mentioned, this factor is never alone; it is supported by one or more of the others. While the supporting factor or factors cannot be singled out by name, it appears, in general, to be something associated with the employee's job and at a level he can cope with. This is borne out by the factors contained in Tables 8, 15, and 19 on pages 28, 39, and 45 respectively.

As would be expected, the previously mentioned fine-grained factors, appearing in Tables 7, 14, and 18 on pages 27, 37, and 44 respectively were not caught in the mesh of this investigation. Possibly they were not present. After all, such fine points as combining movements, combining delays, etc., are expected to be beyond the reasonable capabilities of the usual operator and fall within the sphere of management or methods engineering.

Another group of factors in this category would be those pertaining to human relations, Tables 9, 16, and 20 on pages 29, 40, and 46 respectively. In broad terms, factors such as morale and working conditions, which by definition encompass workers as a group rather than as individuals, are also beyond the usual scope of the operator and fall within the domain of management.

As a specific example, let us consider safety at NAD Crane. While this item receives preferential consideration, few of the suggestions were related to what one would consider the prevention of major disasters for an activity of that kind; the majority of Crane's suggestions were, in reality, the kind to be expected in any manufacturing establishment. After a little thought, this is what one would expect. NAD Crane was designed and built by experts and technicians in the field of explosives. How what possibility has the usual employee with only a farming background of coming up with an acceptable suggestion of this type? If conditions were present for him to accomplish this, he probably would not live long enough to reach for a pencil!

Thus it seems clear that an employee's best chance of submitting a winning beneficial suggestion, yet containing a minimum number of factors, is to:

1. Improve his own job, the one he is familiar with.
2. Save the activity money in a way that can be measured with reasonable ease.
3. Avoid the fine-grained factors that - while measurable - only show savings in mass production or continuous manufacture.
4. Avoid the human relations factors - they belong to management.

However, as mentioned on page 34, when several factors are employed, a combination of both tangible and intangible items results in the highest correlation with the criterion - winning.

[illegible]

APPENDIX

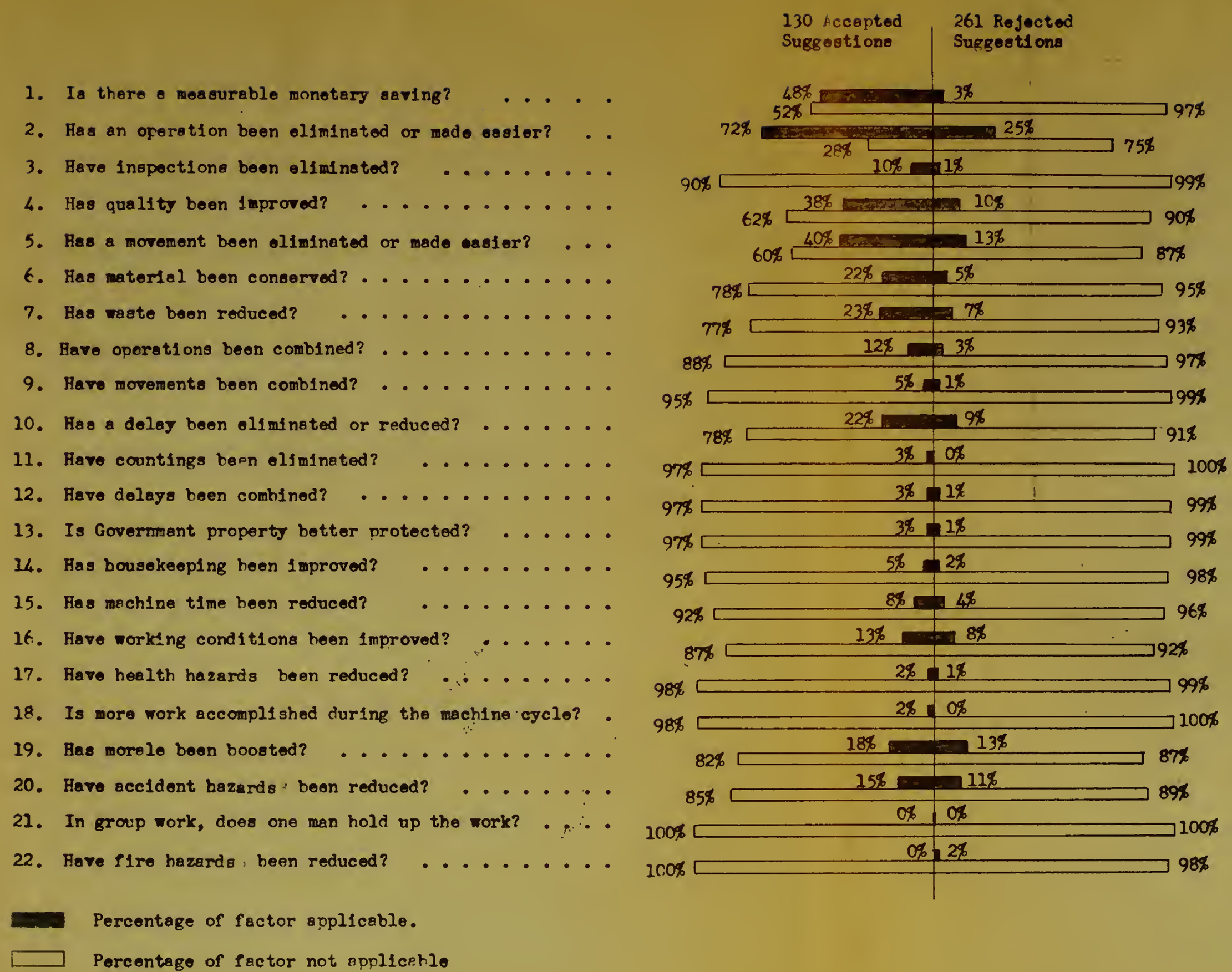

Fig. 2 The percentage of suggestions possessing and not possessing various factors at NOPI.

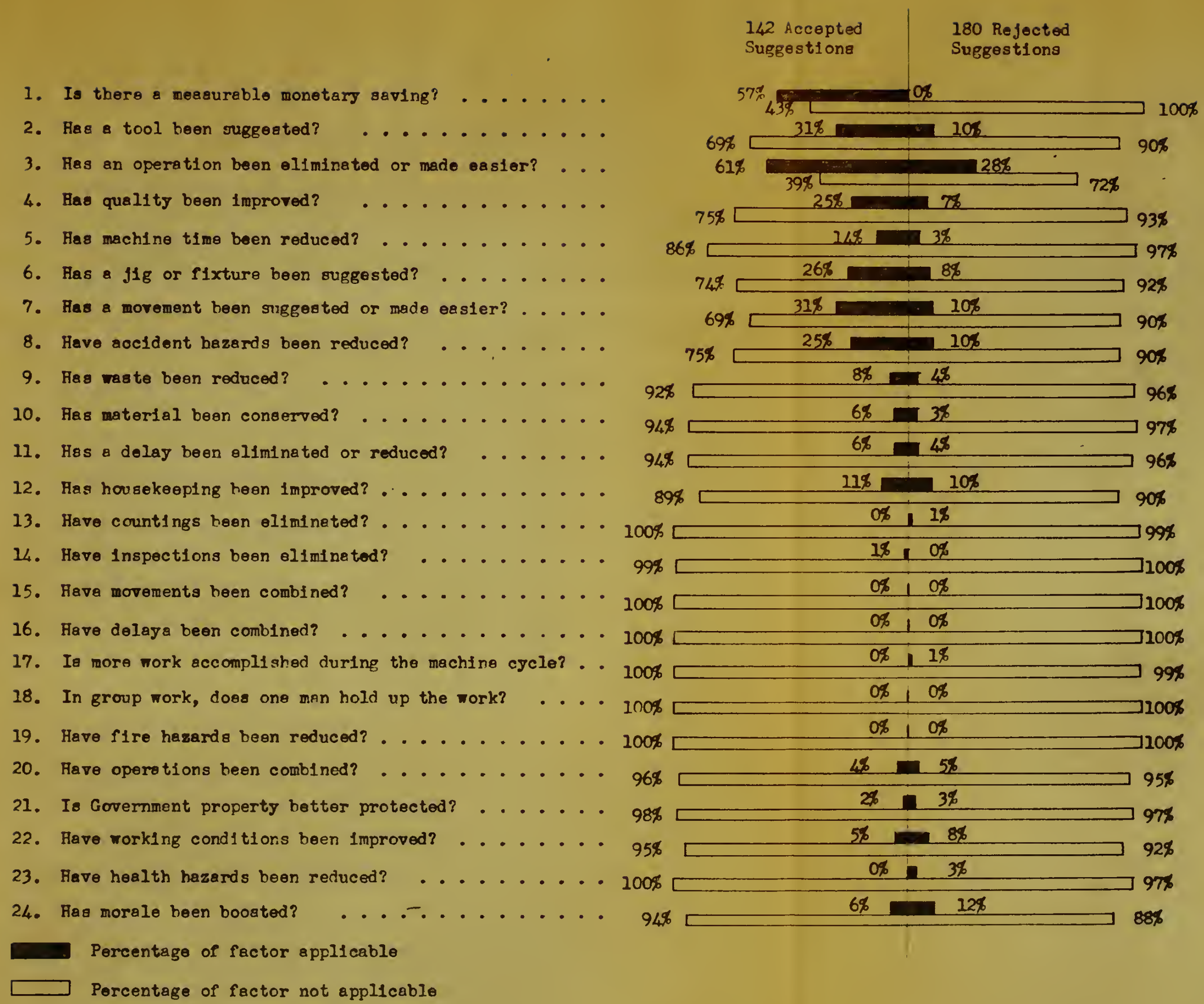

Fig. 3 The percentage of suggestions possessing and not possessing various factors at NOP-FP

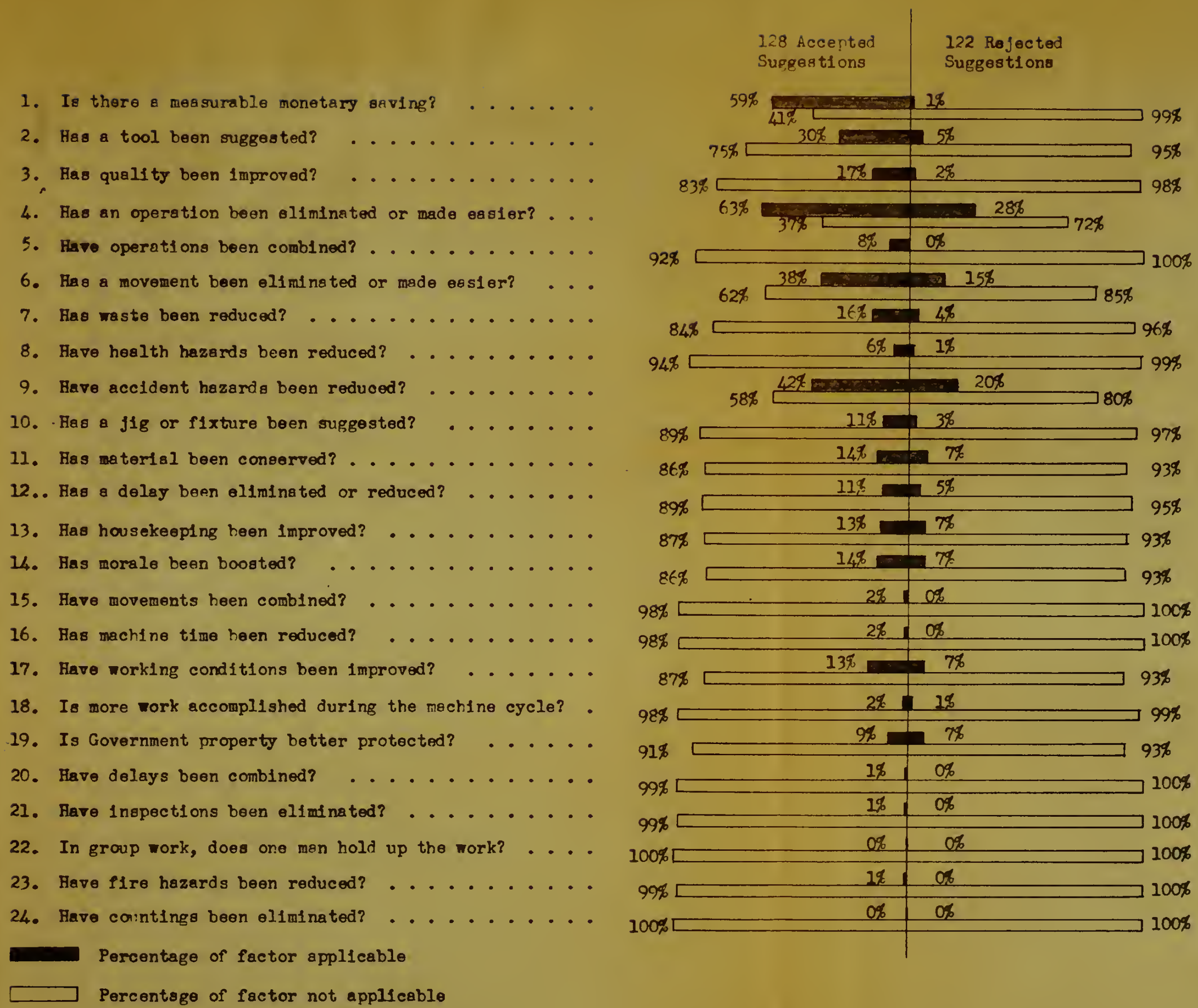

Fig. 4 The percentage of suggestions possessing and not possessing various factors at NAD Crane

AUTHOR Humphreys

TITLE An analysis of the factors t-
contributing to an acceptable es-
beneficial suggestion